Assessing the Ability of Agricultural Socialized Services to Promote the Protection of Cultivated Land among Farmers

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Abstract: Protecting and improving the quality of cultivated land is important to agricultural modernization. Based on data from a survey of 706 rice-growing households in Hunan, Jiangxi and Jiangsu, this paper uses the Probit model, CMP method and Biprobit model to systematically analyze the impact of agricultural socialized services on farmers’ cultivated land quality protection behaviors. This study finds that agricultural socialized services have a significantly positive impact on the adoption of soil testing formulas and straw returning technology among farmers, which can improve both the probability and the degree of cultivated land quality protection. The heterogeneity test results suggest that agricultural socialized services provide a higher incentive for the older generation of farmers to adopt arable land quality protection. In addition, we found that agricultural socialized services are more conducive to the protection of contracted land than transferred land. Therefore, we recommend that policies on agricultural socialized services be further implemented, the supply of agricultural socialized services be optimized, and the role of service organizations in publicizing and promoting cultivated land protection techniques be brought into play. We also posit that the simultaneous encouragement of farmers in using agricultural socialized services would protect the quality of cultivated land. During this process, additional attention should be paid to the response differentiation of peasants with different characteristics.

Keywords: agricultural socialized services; cultivated land quality protection; soil testing formula; straw returning; CMP method

1. Introduction

Cultivated land is the lifeblood and main carrier of food production. However, China is a developing country with more people and less land; China’s per capita cultivated land area is less than 0.1 ha [1]. It is therefore crucial to use cultivated land intentionally to ensure food security throughout the country [2,3]. Due to the accelerated process of urbanization and the rapid development of the economy, a great deal of high-quality cultivated land has been occupied for living purposes, while the wider demand for food is increasing. In conjunction, these factors make the need for food security ever more important [4]. Faced with decreasing cultivated land and increasing demand, cultivated land is being overloaded by high-intensity use. Furthermore, there are long-term problems such as excessive application of fertilizers, which causes the decline of soil fertility and puts additional strain on the available cultivated land [5,6], seriously restricting sustainable agricultural development. The Bulletin of National Cultivated Land Quality Grades in 2019 shows that 68.76% of China’s cultivated land was of medium or low quality by the end of 2019. While this percentage was 1.74% lower than in 2016, the overall quality remained low. The Chinese government has always attached great importance to cultivated land protection, especially in light of population growth, and regarded it as a basic national policy. Over the past 40 years, the government has formulated a series of policies, including cultivated land balance programs and permanent basic farmland protection system [7,8].
Notably, in 2015, the Ministry of Agriculture issued the Action Plan for the Protection and Enhancement of Cultivated Land Quality, suggesting that cultivated land protection should implement the concepts of an “equal emphasis on quantity and quality” and a “combination of land use and nutrients”, as well as encouraging producers to adopt measures that combine land use and nutrients to curb the rising problem of soil quality. In the No. 1 Central Document of the Communist Party of China in 2022, the issue of farmland management is directly addressed, stating that measures to protect farmland must have teeth. Furthermore, it states that local party committees and governments at all levels should be held strictly accountable for farmland protection.

Currently, the overarching design created to ensure the protection and improvement of cultivated land quality in China has been relatively well deployed. However, as the most direct users and beneficiaries of cultivated land, farmers undoubtedly play a critical role in the protection of cultivated land quality [9,10], and the success of cultivated land protection ultimately depends on the transformation of farmer behaviors on a local level [11]. Existing studies show that many factors influence farmland quality conservation behaviors among farmers, including both intrinsic individual factors, such as a farmer’s personal characteristics [12], household characteristics [13], production characteristics [14], subjective cognition [15,16], and extrinsic environmental factors such as policy incentives [17], farmland property rights [18], and publicity and guidance [19]. However, farmers are often poorly motivated to enact protective behaviors due to strong positive externalities and the uncertainty of cultivated land quality protection [20]. Recently, the space for specialized division of labor in agriculture has been widened by the progress of technology and the transfer of rural labor. This shift has induced smallholder family operations to become involved in the division of labor through service scale operations that promote the effective linkage of smallholder farmers to modern agricultural practices, while providing new methods of promoting cultivated land quality conservation by farmers to farmers [21,22].

Recent research indicates that agricultural socialized service organizations—with their technological, capital and human strengths—have implanted advanced elements into the agricultural industry chain that alleviate the adverse effects of smallholder resource shortages and fragmented operations. Contact between smallholder farmers and socialized service organizations may facilitate the adoption of farming techniques, improvements in agricultural efficiency and the reduction in fertilizer application [23,24]. In China, agricultural socialized services are an agricultural business model in which cooperatives, private agricultural service firms, and self-employed agricultural service agents provide agricultural services in all aspects of agriculture before, during and after production to smallholder farmers, such as agricultural materials supply, machine-rent, labor-hire services and so on [25]. Due to the reforms enacted by the government at the end of 2020, there were over 900 thousand agricultural socialized service organizations in China, and the service area of agricultural production trust reached 1.67 billion mu (1 ha = 15 mu), serving more than 78 million small farmers.

Protecting and improving the quality of cultivated land is an effective way to encourage agricultural modernization. A review of existing literature suggests that there is no unanimous conclusion regarding the ability of agricultural socialized services to create sweeping changes in land protection practices among smallholder farmers. Currently, the scholarly community generally accepts that agricultural socialized services have a positive impact on agricultural production. For instance, evidence shows that agricultural socialized services reduce costs and increase efficiency, as well as crop yields and incomes [26–30]. They can also encourage farmers to improve their production and management practices, such as stimulating them to reduce the application of chemical fertilizers and pesticides [31,32], adopt green production techniques [21] and increase farmers’ green agricultural production intentions [33], etc. These behaviors have a positive effect on improving the quality of cultivated land. However, there are reservations among some scholars who argue that agricultural socialized services had no significant impact on fertilizer reduction [34] and who think the services may even lead to the misuse of inputs.
for profit motives [35], causing damage to the quality of cultivated land. Zheng and Zhang (2022) found that only the purchase of professional outsourcing services can significantly reduce the probability of pesticide overuse [36].

Most of the previous studies on this topic have focused on the relationship between agricultural socialized services and the reduction in fertilizer and pesticide application or the adoption of green technologies. However, few studies have focused on the protection of cultivated land quality, and the conclusions are still divergent. The relationship between agricultural socialized services and cultivated land quality protection needs to be further clarified. In particular, farmers’ farmland conservation behaviors directly determine the quality of farmland conservation [37]. Moreover, we assess whether or not agricultural socialized services have a positive impact on farmland quality conservation behaviors. To this end, this paper examines the impact of agricultural socialized services on cultivated land quality conservation behaviors among farmers based on survey data from 706 rice-growing households in three major rice-producing provinces: Jiangxi, Hunan and Jiangsu. The aim of this paper is to reveal the influence of agricultural socialized services on farmers’ behaviors, and thus uncover the underlying mechanisms and feasible strategies that are successful in promoting the conservation of farmland quality.

Compared with previous studies, this paper has two main contributions. Firstly, it analyses the impact of agricultural social services on cultivated land quality protection by using research data from rice farmers and refines the theory of social division of labour and farmers’ behavior. Secondly, considering the influence of endogeneity and the complementary or alternative relationships of dependent variables on the results, the article uses the CMP method and Biprobit model for regression, which effectively overcomes the potential estimation bias. A further robustness test uses the degree of adoption of cultivated land conservation technology as the explanatory variable, which addresses the problem of focusing on whether or not to adopt but ignoring the deficiency of the degree of adoption and improves the credibility of the estimation.

The remainder of the study is structured as follows: Section 2 presents the theoretical framework of the study. Section 3 presents the data sources, variables, and methods. Section 4 provides empirical results and analysis. Section 5 draws conclusions and makes policy recommendations.

2. Theoretical Analysis and Research Hypothesis

2.1. Impact of Agricultural Socialized Services on the Conservation of Farmland Quality

The primary incentive for farmers to protect the quality of their cultivated land hinges on whether they can maximize their household income [38]. Schultz’s rational smallholder theory posits that farmers are the subjects of agricultural production, and their situational rationality dictates that their production behaviors and objectives will be shaped by changes in the market environment, agricultural technology, and the allocation of production factors. This means that farmers will be driven to make choices that are conducive to maximizing household returns [39]. The protection of cultivated land quality has wide-ranging externalities and attributes that benefit the public. The fruits of farmland protection are shared across society, yet the risks and costs have to be borne by the farmers themselves [40]. So, farmers are not highly motivated to take the initiative to protect cultivated land quality. At the same time, due to their own constraints, farmers lack sufficient capacity to protect the quality of their farmland and are faced with the problems of unwillingness and inability to do so.

The promotion of urbanization encourages a large amount of young rural labor to transfer into urban areas, resulting in the extreme differentiation of rural and urban populations [25]. It can be seen that the farming career opportunities present little or no interest to younger people. Even those people who run a large-scale farm, expect a bigger income in return for less demanding occupation [41]. Moreover, as the comparative income from agriculture declines, the degree of part-time farming intensifies, and the structure of production factors changes; labor becomes a scarce resource for both large-scale operators and
traditional smallholder farmers, and there is a call to optimize the allocation of agricultural resources to achieve technological substitution of labor [42]. According to the theory of induced technological change, to dynamically optimize resource allocation farmers will decide whether to engage in factor substitution depending on the scarcity of resources at their disposal [43]. There are many forms of agricultural resource allocation, including self-farming, employing labor for production and service outsourcing. For the sake of reducing marginal costs, agricultural socialized services with scale and technological advantages become a practical choice for farmers to carry out factor substitution [44]. Agricultural socialized services fundamentally alter the input profiles of farmers and the agricultural production and management practices they use, as well as alleviating various financial constraints in the conservation of farmland quality. As shown in Figure 1, $Q_1$ and $Q_2$ denote the quantity of cultivated land quality protection inputs before and after agricultural socialized services, respectively; $K_1$ and $K_2$ represent capital inputs; $L_1$ and $L_2$ are labor inputs; and $e_1e_2$ is the equal cost curve, which indicates all sets where the product of capital and labor costs is equal to $K_1L_1$. Since both $A_1$ and $A_2$ are on the equal cost curve, $K_1L_1 = K_2L_2$. In other words, at the same cost, the use of agricultural socialized services will increase the amount of input for cultivated land quality protection, while reducing labor input and promoting labor transfer, thus increasing agricultural business income and wage income [45]. This fiscal shift indicates a way to motivate farmers to implement land quality protection practices, and so solves the problem of farmer reluctance.

![Figure 1](image.png)

Figure 1. Mechanisms of impact of agricultural socialized services on agricultural production.

From the perspective of service demand, cultivated land quality protection can be achieved by purchasing relevant elements by yourself, and through self-invested labor, or through hiring labor, but these methods require a higher initial investment and are not the best option for small farmers. The rapid development of agricultural socialized services has given farmers access to lower-cost and higher-level services. By outsourcing services, farmers gain access to the superior resources of service organizations [46], reduce agricultural production costs and weak labor constraints [47,48], and can therefore promote cultivated land quality conservation with optimal allocation. In terms of service provision, agricultural socialized services share the risk of investment in technology or equipment and improve resource utilization by integrating the needs of dispersed farmers, who have the opportunity to obtain better service with lower input [49]. Agricultural socialized services not only help farmers obtain more accurate information on cultivated land quality protection, but also enhance their ability to identify farmland quality protection technologies. This increases the accessibility of such technologies for farmers to deploy when
implementing farmland quality protection and solves the problem of fiscal or technological inability to enact farmland quality protection. As a result, the following research hypothesis is proposed.

**H1.** *Agricultural socialized services contribute to the conservation of farmland quality.*

### 2.2. Inter-Group Differences in the Protection of Farmland Quality by Agricultural Socialized Services

The role of agricultural socialized services in protecting the quality of farmland for small farming households may be influenced by intrinsic factors due to a large variability among farming households across China. Due to the accelerated urbanization of Chinese communities, rural households are often characterized by diversification. Farmers of different ages pay different attention to agriculture and have different dependence on land. Rural households with younger heads derive more of their household income from non-farm work, with agriculture no longer a primary option and with little incentive to work in intensive farming. Rural households with older heads, on the other hand, are at a relative disadvantage in terms of education and health, and are statistically less capable of non-farm employment, with agricultural production still occupying an important position [50]. While rural homes with older heads of household can be slower to adopt new technologies and receive new information, the ability of agricultural socialized services to increase the amount and the quality of labor will make the utility of these services integral to alleviating resource constraints. Therefore, we conclude that the contribution of agricultural socialized services to cultivated land quality conservation is more pronounced for farmers with older heads of household.

Under the “separation of three rights” system of rural contracted land, land is being transferred more and more frequently, and farming land operated by farmers may include both their own land and transferred farmland. Out of moral hazard, existing studies have found that there are differences in the long-term investment decisions between contracted and transferred land [51]. For instance, farmers are more likely to apply organic fertilizer on their own land [52]. According to the theory of property rights, stable, clear and long-term land rights encourage farmers to invest in long-term soil improvement [53]. However, the lack of tenure on transferred land coupled with the long investment period required for cultivated land quality conservation discourages farmers from applying cultivated land quality conservation on land they may not own in the future. At the same time, the controlling preference of the transferring households prevents predatory practices by the transferring households through higher rents and short-term contracts, but this weakens the incentive among farmers to invest in the transferred land in the long term [54]. It follows that although agricultural socialized services alleviate farmers’ resource constraints, farmers will, ceteris paribus, prioritize long-term investments in cultivated land quality protection on contracted land. In summary, this paper proposes the following hypothesis:

**H2.** *The contribution of agricultural socialized services to cultivated land quality conservation is more pronounced for farmers with older heads of household than for those with younger heads of household.*

**H3.** *The contribution of agricultural socialized services to the conservation of cultivated land quality on contracted land is more significant than that on transferred farming land.*

### 3. Data Description and Model Construction

#### 3.1. Data

The data in this paper comes from a survey of rice-growing households conducted by the TREE group of Nanjing Agricultural University in November–December 2017 in the three main rice-producing provinces of Hunan, Jiangxi and Jiangsu. Among them, farm household data are based on the year-end situation in 2017, while agricultural production data are based on the final season of rice planting in 2017. These three provinces were
chosen because they are all among the top 10 rice-growing provinces in the country but have different levels of economic development and are broadly representative of the larger Chinese landscape.

The research used a stratified random sampling method to select three key counties in each province for excellent, medium and low rice production based on economic conditions and rice yields. Specifically, Hanshou, You and Heshan were selected in Hunan; Fenyi, Xinyu and Anyi, were selected in Jiangxi; and Jintan, Gaoyou and Pei were selected in Jiangsu (Figure 2). In addition, four main rice-producing villages were randomly selected from each key county for a total of 36 sample villages. Then, 20 rice farmers were selected from each village according to the list provided by the village committee to conduct one-on-one questionnaire surveys with researchers. Sampling was carried out according to the principle of random sampling. A total of 36 villages in 9 counties participated, with data collected from 733 farming households (including 240 in Hunan, 251 in Jiangxi, and 242 in Jiangsu). Excluding samples with insufficient information and without rice cultivation, the final sample size used for empirical analysis was 706.

Figure 2. Distribution map of the sample area.

3.2. Variables
3.2.1. Dependent Variable

There is a rich field concerned with cultivated land quality protection, which can be generally divided into two main categories: nutrient balance and organic matter enhancement. Drawing on the existing literature, two types of techniques, soil formulation and straw return, are used in this paper [9]. The former emphasizes the science and precision of fertilizer application, which not only reduces the use of chemical fertilizers, but also achieves a balance of nutrients in cultivated land; the latter boosts the utilization of resources and contributes to the upgrading of organic matter. Both types are common techniques for improving the quality of cultivated land as well as being typical of those promoted by the state in recent years. Specifically, a value of 1 is assigned when the farmer adopts the farmland protection technology, and 0 otherwise. To better measure the impact of agricultural socialized services on the adoption of farmland protection technologies, this paper introduces technology adoption indicators into the robustness regressions, which are expressed as the proportion of area fertilized with soil testing formulae and the proportion of straw returned to the field, respectively.
3.2.2. Key Explanatory Variables

Agricultural socialized services are the key explanatory variable in this paper. The term refers to the number of agricultural socialized services that farmers receive or purchase from various social service organizations. Specifically, the rice-growing process is divided into seven stages: tillage, seedling cultivation, sowing, fertilization, application of pesticides, irrigation and harvesting. Based on any outsourcing measured in each segment, we use the degree of outsourcing to indicate the level of agricultural socialized services.

3.2.3. Control Variables

According to current studies [42,55,56], three types of control variables, including household head characteristics, household characteristics and cognitive characteristics, are introduced in this paper to control for variables as far as possible. The household head is usually the farming decision-maker and has a key role in the adoption of farmland conservation technologies. In this paper, three indicators—age, educational level and physical quality—are used to assess the characteristics of the household head. These characteristics in turn reflect the level of agricultural production, the conditions of production and the significance of the household. For instance, they determine whether the household participates in a cooperative, whether it is a model household, the number of household laborers, the annual household income and the scale of rice cultivation. Cognitive characteristics look to farmer participation in training and technology awareness. It is generally accepted that technology training will improve an individual’s understanding of technology and thus promote technological adoption. To ensure the consideration of policy supervision, straw burning penalties were included in the straw return technology adoption model.

Based on the descriptive statistics shown in Table 1, the percentage of farmers who returned straw to the fields in the survey sample was 74.9%. This is due to the fact that returning straw to the fields contributes to increasing soil organic matter and fertilizing the soil. Furthermore, the government has introduced policies to ban straw burning successively in recent years. Because of these policies, the popularity of mechanical harvesting services with straw shredding has increased the adoption rate of straw return technology from both the sides of the debate. Although the government has made great efforts to promote soil measured fertilizers—investing a total of CNY 9.2 billion in the promotion of soil testing formula fertilization technology up to 2016—the difficulty of implementing the technology and the amount of labor required, is reflected in the adoption rate, which remains low at only 11.2% of the sample.

\[ \text{Table 1. Descriptive statistics of variables.} \]

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Mean</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil testing</td>
<td>Whether to apply soil-measured fertilizer: 0 = Not adopted; 1 = Adopted</td>
<td>0.112</td>
<td>0.315</td>
</tr>
<tr>
<td>Straw returning</td>
<td>Whether to return straw to the field: 0 = No; 1 = Yes</td>
<td>0.749</td>
<td>0.434</td>
</tr>
<tr>
<td>Degree of soil testing</td>
<td>Percentage of area fertilized with soil testing</td>
<td>0.099</td>
<td>0.294</td>
</tr>
<tr>
<td>Extent of straw returning</td>
<td>Proportion of rice straw returned to the field</td>
<td>0.763</td>
<td>0.412</td>
</tr>
<tr>
<td>Agricultural socialized services</td>
<td>Degree of rice farming chain outsourcing</td>
<td>0.312</td>
<td>0.227</td>
</tr>
<tr>
<td>Age</td>
<td>Age of household head (years)</td>
<td>57.137</td>
<td>10.316</td>
</tr>
<tr>
<td>Education</td>
<td>Education level of household head (years)</td>
<td>10.538</td>
<td>4.925</td>
</tr>
<tr>
<td>Physical quality</td>
<td>Physical quality of household: 0 = incapacity to work;</td>
<td>2.955</td>
<td>1.047</td>
</tr>
<tr>
<td>Membership</td>
<td>Cooperative membership: 0 = No; 1 = Yes</td>
<td>0.183</td>
<td>0.387</td>
</tr>
<tr>
<td>Demonstration household</td>
<td>Demonstration household: 0 = No; 1 = Yes</td>
<td>0.184</td>
<td>0.388</td>
</tr>
<tr>
<td>Labor</td>
<td>Number of household labor (people)</td>
<td>2.810</td>
<td>1.576</td>
</tr>
<tr>
<td>Annual household income</td>
<td>Total household income for the year (10$^4$-yuan CNY)</td>
<td>9.380</td>
<td>12.023</td>
</tr>
<tr>
<td>Scale of rice cultivation</td>
<td>Logarithm of rice cultivation area</td>
<td>2.523</td>
<td>1.580</td>
</tr>
<tr>
<td>Soil testing train</td>
<td>Whether participated in training on soil testing: 0 = No; 1 = Yes</td>
<td>0.120</td>
<td>0.326</td>
</tr>
<tr>
<td>Straw returning train</td>
<td>Whether participated in training on straw return: 0 = No; 1 = Yes</td>
<td>0.169</td>
<td>0.375</td>
</tr>
<tr>
<td>Cognition of soil testing</td>
<td>Impact on soil quality: 1 = very poor impact; 2 = comparatively poor impact; 3 = no impact; 4 = comparatively good impact; 5 = exceptionally good impact</td>
<td>3.473</td>
<td>0.665</td>
</tr>
<tr>
<td>Cognition of straw returning</td>
<td>As above</td>
<td>3.762</td>
<td>0.730</td>
</tr>
<tr>
<td>Punishment for straw burning</td>
<td>Whether the local government is fined or detained for burning straw: 0 = No; 1 = Yes</td>
<td>0.125</td>
<td>0.331</td>
</tr>
</tbody>
</table>
3.3. Model
3.3.1. Probit Model

Whether or not a farmer adopts cultivated land conservation technology is a binary, discrete variable. In this paper, the impact of agricultural socialized services on the adoption of cultivated land conservation technology by farmers is examined empirically using a binary Probit model in a discrete regression model, which is set up as follows:

\[ p = p(y = 1|X) = \Phi(\delta_0 + \delta_1 X_1 + \sum \delta_i X_i) \]  

In (1), \( p \) is the explained variable of whether the farmer adopts the conservation technology, \( X_1 \) is the key explanatory variable of the degree of socialization, \( X_i \) is the other control variables affecting the adoption of the conservation technology, \( \Phi \) is the standard normal distribution function, and, \( \delta_0, \delta_1 \) and \( \delta_i \) are the estimated coefficients.

3.3.2. Treatment of Endogeneity

In the process of agricultural production and management, a farmer’s decisions to participate in agricultural socialized services may coincide with their adoption of farmland conservation technologies. This situation may lead to the endogeneity of agricultural socialized services variables when attempting to identify the impact of agricultural socialized services on the adoption of farmland conservation technologies among farmers. In this paper, the conditional mixed process (CMP) approach [57] is used to address this issue. The CMP method was tested by constructing a two-stage regression model based on a seemingly uncorrelated regression. In particular, the instrumental variables are selected in the first stage and assessed for correlation with the core explanatory variables. In the second stage, the instrumental variables are included in the model and subsequently tested for endogeneity based on whether the endogeneity test parameter (atanhrho_12) is significantly different from zero. If the parameter is significantly different from zero, the model is endogenous. Considering the instrumental variables the CMP method results in better estimates, but otherwise, the estimates of Probit or Tobit models prevail.

As to the selection of instrumental variables, the basic conditions of high relevance and strict exogeneity must be met. In this paper, we use the average level of agricultural socialized services in villages other than the household of the head of household as the instrumental variable of agricultural socialized services [58]. On the one hand, the use of agricultural socialized services by other farmers in the village is transmissive and directly affects an individual’s decisions to adopt agricultural socialized services, thus the instrumental variable and the endogenous variable satisfy the correlation condition; on the other hand, a farmer’s decisions to adopt farmland protection technologies is a joint household decision and would not be affected by an external farmer’s purchase of agricultural socialized services, hence the condition of strict exogeneity can be fulfilled. In summary, this paper uses the CMP method for joint likelihood estimation using the baseline model to improve the robustness and credibility of this study’s results.

4. Empirical Analysis Results
4.1. Baseline Regression

According to model (1), the Probit equation was estimated using Stata 16.0 software. Columns (1) and (3) of Table 2 show the estimated results of agricultural socialized services on the adoption of cultivated land conservation technology by farmers. The table shows that agricultural socialized services significantly influence the application of soil testing fertilizer by farmers positively at the 5% level, indicating that agricultural socialized services can increase the probability of adoption of the technology. On the basis of the marginal effect results, the probability of farmers applying soil-measured fertilizer increased by 0.089% for every 1% increase in the level of agricultural socialized services. Agricultural socialized services also had a positive effect on the probability of farmers returning straw to the field, with a significance level of 1%. Each 1% increase in the level of agricultural socialized
services signifies an increase in the probability of farmers returning straw to the field by 0.399%. The potential reason for this is that agriculture socialized service organizations have the advantage of professionalism and scale, which enables them to provide a more professional service at a lower cost. Therefore, hypothesis H1 was tested.

Table 2. Regression results on the impact of agricultural socialized services on the adoption of cultivated land conservation techniques.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Soil Testing (1)</th>
<th>Soil Testing (2)</th>
<th>Straw Returning (3)</th>
<th>Straw Returning (4)</th>
<th>BiProbit Model (5)</th>
<th>BiProbit Model (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture socialized services</td>
<td>0.588 **</td>
<td>1.456 ***</td>
<td>1.489 ***</td>
<td>3.277 ***</td>
<td>0.563 **</td>
<td>1.534 ***</td>
</tr>
<tr>
<td></td>
<td>(0.283)</td>
<td>(0.534)</td>
<td>(0.308)</td>
<td>(0.460)</td>
<td>(0.283)</td>
<td>(0.307)</td>
</tr>
<tr>
<td>Age</td>
<td>0.010</td>
<td>0.011</td>
<td>−0.010</td>
<td>−0.009 *</td>
<td>0.011</td>
<td>−0.010</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.005)</td>
<td>(0.008)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Education</td>
<td>−0.003</td>
<td>−0.001</td>
<td>−0.034 ***</td>
<td>−0.030 ***</td>
<td>−0.003</td>
<td>−0.035 ***</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.011)</td>
<td>(0.010)</td>
<td>(0.016)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Physical quality</td>
<td>0.158 *</td>
<td>0.132</td>
<td>0.173 ***</td>
<td>0.129 **</td>
<td>0.163 *</td>
<td>0.176 ***</td>
</tr>
<tr>
<td></td>
<td>(0.084)</td>
<td>(0.084)</td>
<td>(0.056)</td>
<td>(0.052)</td>
<td>(0.084)</td>
<td>(0.056)</td>
</tr>
<tr>
<td>Membership</td>
<td>0.131</td>
<td>0.100</td>
<td>0.298</td>
<td>0.189</td>
<td>0.146</td>
<td>0.336</td>
</tr>
<tr>
<td></td>
<td>(0.180)</td>
<td>(0.177)</td>
<td>(0.201)</td>
<td>(0.182)</td>
<td>(0.179)</td>
<td>(0.205)</td>
</tr>
<tr>
<td>Demonstration household</td>
<td>0.372 **</td>
<td>0.348 *</td>
<td>−0.185</td>
<td>−0.173</td>
<td>0.365 **</td>
<td>−0.188</td>
</tr>
<tr>
<td></td>
<td>(0.185)</td>
<td>(0.181)</td>
<td>(0.197)</td>
<td>(0.178)</td>
<td>(0.183)</td>
<td>(0.196)</td>
</tr>
<tr>
<td>Labor</td>
<td>−0.050</td>
<td>−0.042</td>
<td>−0.048</td>
<td>−0.034</td>
<td>−0.045</td>
<td>−0.053</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.049)</td>
<td>(0.036)</td>
<td>(0.032)</td>
<td>(0.049)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>Annual household income</td>
<td>−0.004</td>
<td>−0.004</td>
<td>0.010</td>
<td>0.008</td>
<td>−0.003</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Scale of rice cultivation</td>
<td>0.113 **</td>
<td>0.107 **</td>
<td>0.062</td>
<td>0.031</td>
<td>0.117 **</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.052)</td>
<td>(0.050)</td>
<td>(0.045)</td>
<td>(0.053)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Cognition of Soil Testing</td>
<td>0.038</td>
<td>0.032</td>
<td>0.120</td>
<td>0.129 *</td>
<td>0.057</td>
<td>0.116</td>
</tr>
<tr>
<td></td>
<td>(0.107)</td>
<td>(0.105)</td>
<td>(0.079)</td>
<td>(0.070)</td>
<td>(0.107)</td>
<td>(0.078)</td>
</tr>
<tr>
<td>Cognition of straw returning</td>
<td></td>
<td></td>
<td>0.943 ***</td>
<td>0.936 ***</td>
<td></td>
<td>0.939 ***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.182)</td>
<td>(0.178)</td>
<td></td>
<td>(0.180)</td>
</tr>
<tr>
<td>Soil testing train</td>
<td></td>
<td></td>
<td>0.278</td>
<td>0.096</td>
<td></td>
<td>0.215</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.202)</td>
<td>(0.187)</td>
<td></td>
<td>(0.199)</td>
</tr>
<tr>
<td>Straw returning train</td>
<td></td>
<td></td>
<td>1.072 ***</td>
<td>0.877 ***</td>
<td></td>
<td>1.016 ***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.282)</td>
<td>(0.257)</td>
<td></td>
<td>(0.274)</td>
</tr>
<tr>
<td>Punishment for straw burning</td>
<td>−3.055 ***</td>
<td>−3.267 ***</td>
<td>0.008</td>
<td>−0.464</td>
<td>−3.225 ***</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>(0.774)</td>
<td>(0.764)</td>
<td>(0.564)</td>
<td>(0.514)</td>
<td>(0.781)</td>
<td>(0.562)</td>
</tr>
<tr>
<td>Constant</td>
<td>−3.055 ***</td>
<td>−3.267 ***</td>
<td>0.008</td>
<td>−0.464</td>
<td>−3.225 ***</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>(0.774)</td>
<td>(0.764)</td>
<td>(0.564)</td>
<td>(0.514)</td>
<td>(0.781)</td>
<td>(0.562)</td>
</tr>
<tr>
<td>Observation</td>
<td>706</td>
<td>706</td>
<td>706</td>
<td>706</td>
<td>706</td>
<td>706</td>
</tr>
<tr>
<td>Atanhrho_12</td>
<td>−0.223 ***</td>
<td>−0.524 ***</td>
<td>−0.524 ***</td>
<td>−0.524 ***</td>
<td>−0.524 ***</td>
<td>−0.524 ***</td>
</tr>
<tr>
<td></td>
<td>(0.124)</td>
<td>(0.135)</td>
<td>(0.135)</td>
<td>(0.135)</td>
<td>(0.135)</td>
<td>(0.135)</td>
</tr>
<tr>
<td>LR chi²</td>
<td>98.61 ***</td>
<td>318.57 ***</td>
<td>127.45 ***</td>
<td>335.38 ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wald chi²</td>
<td>176.43 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wald Test</td>
<td>8.428 ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ***, **, * denote significance at the 1%, 5% and 10% levels, respectively, with robust standard errors in parentheses. The first stage regression results of the CMP method are not presented due to space limitations.

Consistent with our findings, ref. [59] found that agricultural productive services can significantly promote farmers’ farmland quality protection behaviors; in addition, the
positive effect of agricultural productive services on motivating cultivated land quality protection behavior is greater in the group of life-oriented farmers than in the group of production-oriented farmers. The author of \[60\] also found that productive services can boost the behavior of farmers in adopting cultivated land quality conservation technologies such as organic fertilizer or straw return technology significantly via the technology diffusion effect. By using agricultural socialized services, farmers introduce new factors and technologies in an indirect ways \[22\], which facilitates their access to a green and efficient supply of services \[61\], while promoting the adoption of new technologies. Thus, agricultural social services promote the adoption of cultivated land quality protection techniques by farmers through demonstration effects and professional advantages.

4.2. Treatment of Endogeneity

Based on the endogeneity of agricultural socialized services the CMP method was used, and due to the possible complementary or alternative relationship between applying soil testing formula and conducting straw regranting we deployed the Biprobit model. The results from both methodologies are shown in Table 2, with CMP in columns (2) and (4), and Biprobit in columns, (5) and (6).

The CMP estimation results demonstrate that the first stage instrumental variable is statistically significant at the 1% significance level, which satisfies the correlation requirement. The Atanhrho_12 estimates are both significantly non-zero at the 1% level in the soil testing and straw return models, indicating that social services have endogeneity problems and are more effectively estimated by using the CMP method. The results in columns (2) and (4) of Table 2 show that agricultural socialized services have a positive impact on both soil testing and straw return at the 1% significance level, with each 1% rise in agricultural socialized services increasing the probability of farmers applying soil testing and straw return by 0.226% and 0.895%, respectively, according to marginal effects. Compared to the baseline regression results, the CMP estimation method measured a higher driving effect of agricultural socialized services on the adoption of farmland conservation technologies among farmers, but the direction of the effect was the same for both methods. Furthermore, according to the Biprobit model estimation results in columns (5) and (6) of Table 2, the Wald test showed a correlation between whether or not farmers applied soil testing fertilizer and whether they carried out straw return. This demonstrates that the Biprobit model estimation also has validity. The results of the Biprobit model are consistent with the results of the Probit model and the CMP approach. All three show that agricultural socialized services significantly contribute to the adoption of conservation technologies by farmers.

4.3. Robustness Test

We used two methods to examine the reliability of the baseline regression results and conduct robust regressions, the results of which are shown in Table 3. First, refer to Chen et al. (2022), 85% of the samples in this paper were randomly selected to constitute a sub-sample of 600, which was regressed using the Probit model and the CMP method, respectively \[62\]. From the CMP estimation results, Atanhrho_12 was significantly non-zero at the 5% level, suggesting that the endogeneity problem still existed in the sub-sample regression and that the estimation was more effective and resulted in more accurate using the CMP method. On the basis of the results in columns (2) and (4) of Table 3, agricultural socialized services positively influenced farmers by encouraging them to apply soil testing fertilizer and carry out straw return at the 1% significance level, which is consistent with the benchmark results and is therefore robust.
Table 3. Robustness test.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Soil Testing</th>
<th>Straw Returning</th>
<th>Degree of Soil Testing</th>
<th>Extent of Straw Returning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Probit (1)</td>
<td>CMP (2)</td>
<td>Probit (3)</td>
<td>CMP (4)</td>
</tr>
<tr>
<td>Agricultural socialized services</td>
<td>0.515 *</td>
<td>1.740 ***</td>
<td>1.515 ***</td>
<td>2.609 ***</td>
</tr>
<tr>
<td></td>
<td>(0.305)</td>
<td>(0.540)</td>
<td>(0.330)</td>
<td>(0.613)</td>
</tr>
<tr>
<td></td>
<td>0.789 **</td>
<td>2.047 ***</td>
<td>0.759 ***</td>
<td>0.845 ***</td>
</tr>
<tr>
<td></td>
<td>(0.363)</td>
<td>(0.775)</td>
<td>(0.083)</td>
<td>(0.174)</td>
</tr>
<tr>
<td>Tool variable</td>
<td>0.899 ***</td>
<td>0.863 ***</td>
<td>0.863 ***</td>
<td>0.863 ***</td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td>(0.053)</td>
<td>(0.053)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Atanhrho_12</td>
<td>−0.257 **</td>
<td>−0.308 **</td>
<td>−0.233 **</td>
<td>−0.249 ***</td>
</tr>
<tr>
<td></td>
<td>(0.130)</td>
<td>(0.156)</td>
<td>(0.117)</td>
<td>(0.080)</td>
</tr>
<tr>
<td>Control variable</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>LR chi²</td>
<td>94.94 ***</td>
<td>266.52 ***</td>
<td>114.24 ***</td>
<td>282.29 ***</td>
</tr>
<tr>
<td></td>
<td>706</td>
<td>706</td>
<td>706</td>
<td>706</td>
</tr>
<tr>
<td></td>
<td>706</td>
<td>706</td>
<td>706</td>
<td>706</td>
</tr>
<tr>
<td></td>
<td>706</td>
<td>706</td>
<td>706</td>
<td>706</td>
</tr>
</tbody>
</table>

Note: ***, **, * denote significance at the 1%, 5% and 10% levels, respectively, with robust standard errors in brackets.

Second, while the degree of adoption varies in reality, the technology adoption decision in the benchmark regression is a 0–1 variable. Therefore, this paper replaces the explanatory variables with the degree of adoption of cultivated land quality protection, and since adoption levels are imputed data, regressions are conducted using the Tobit model and the CMP method, individually. Based on the results in Table 3, the Atanhrho_12 test reconfirms that there is an endogeneity problem with socialized services. This means that compared to the Tobit model, the CMP method estimates are more reliable. As demonstrated by the results in columns (6) and (8) of Table 3, agricultural socialized services significantly and positively influence farmers’ adoption of soil testing and straw return technology at the 1% level. This further confirms that agricultural socialized services notably facilitate the adoption of farmland conservation technologies among farmers. Thus, we determine that hypothesis H1 is robust and plausible.

4.4. Heterogeneity Analysis

It is clear from the above results that the quality of farmland is influenced by many factors, including both external environmental factors and a farmer’s personal characteristics. In order to further analyze the differential impact of agricultural socialized services on the quality protection of farmland owned by farmers with different characteristics, we drew on existing results and divided the entire sample into different types of sub-samples from the perspective of age differences at the individual level, and contracted land and transferred land differences at the operational level, and regressions were conducted on the sub-samples to examine the heterogeneous impact of agricultural socialized services.

4.4.1. Comparative Analysis of Different Generations of Farmers

This paper classifies the senior and junior generations by whether the household head is older than the sample mean. The results in Table 4 show that agricultural socialized services have a positive effect on the application of soil testing fertilizer and straw return to the field for the senior generation, and pass the 1% significance level; however, in the junior generation, agricultural socialized services can significantly promote the application of straw return to the field, but not the application of soil testing fertilizer. Meanwhile, the marginal effect of agricultural socialized services on the adoption of conservation techniques by the senior generation was greater. This may be due to the fact that the older generation of farmers has a more constrained budget for cultivated land quality conservation; they were carefully calculated in the production process. By relying on agricultural social service organisations, it is possible to purchase production factors at a lower cost than the market price. Therefore, the effects brought about by agricultural socialized services are more pronounced. This result is in line with [31]. Furthermore, as [63] suggests, older farmers have more difficulty in mastering complex agricultural services.
technologies and are more inclined to delegate decisions on these technologies to regulated agricultural social service organisations. Thus, hypothesis H2 is partially tested.

Table 4. Comparative analysis of different generations of farmers.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Soil Testing</th>
<th>Straw Returning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Senior Generation</td>
<td>Junior Generation</td>
</tr>
<tr>
<td>Agricultural socialized services</td>
<td>0.221 *** (0.067)</td>
<td>0.014 (0.058)</td>
</tr>
<tr>
<td>Control variable</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>LR chi²</td>
<td>84.54 ***</td>
<td>35.56 ***</td>
</tr>
<tr>
<td>R²</td>
<td>0.372</td>
<td>0.133</td>
</tr>
<tr>
<td>Observation</td>
<td>330</td>
<td>376</td>
</tr>
</tbody>
</table>

Note: Coefficients and standard errors in the tables are after calculating the average marginal effect; *** and ** indicate significance at the 1% and 5% levels, respectively.

4.4.2. Comparative Analysis of Contracted and Transferred Land

Contracted land and transferred land are two distinct types of land. To examine any differences between land types in relation to the impact of agricultural socialized services on the adoption of conservation techniques by farmers, we conducted regression analyses for contracted and transferred land, and the results are shown in Table 5. The empirical results show that the coefficients of agricultural socialized services are all significantly positive for the contracted land group, implying that agricultural socialized services can motivate farmers to protect contracted land. For the transferred land group, the coefficients of agricultural socialized services are still positive, but the results are not significant, implying that agricultural socialized services struggle to motivate farmers to protect transferred land. This indicates that farmers treat contracted land differently from transferred land in terms of quality protection of farmland, which may be due to the instability of property rights on transferred land and the long payback period of cultivated land protection, which limits the effect of socialized services. Thus, research hypothesis H3 is tested.

Table 5. Comparative analysis of contracted land transferred land.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Soil Testing</th>
<th>Straw Returning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contracted Land</td>
<td>Transferred Land</td>
</tr>
<tr>
<td>Agricultural socialized services</td>
<td>0.108 ** (0.044)</td>
<td>0.029 (0.085)</td>
</tr>
<tr>
<td>Control variable</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>LR chi²</td>
<td>90.15 ***</td>
<td>29.87 ***</td>
</tr>
<tr>
<td>R²</td>
<td>0.197</td>
<td>0.114</td>
</tr>
<tr>
<td>Observation</td>
<td>677</td>
<td>270</td>
</tr>
</tbody>
</table>

Note: Coefficients and standard errors in the tables are after calculating the average marginal effect; *** and ** indicate significance at the 1% and 5% levels, respectively.

5. Conclusions and Recommendations

This paper examined the impact of agricultural socialized services on the adoption of cultivated land quality protection among farmers, using two types of cultivated land quality protection technologies: soil testing and straw returning. Based on survey data from 706 rice farmers in Jiangsu, Jiangxi, and Hunan, the results show that agricultural socialized services have a catalytic effect on farmland quality protection behaviors among farmers. Considering the issues of endogeneity and correlation of variables, we conducted regressions using the CMP method and Biprobit model separately, and the results support the above findings. To improve the reliability of the results, we conducted robustness tests.
using sub-samples and replacement variables, which again verified that the results were robust, and also confirmed that agricultural socialized services not only promoted farmers’ farmland quality conservation behaviors, but also increased the degree of farmland quality conservation. The results also demonstrate that considering the heterogeneous effects of agricultural socialization services on the behaviors of farmers with different characteristics is important. This paper conducts a multidimensional heterogeneity analysis of the impact of agricultural socialization services on farmland quality protection in terms of both age and business differences. We found that social farming services can contribute more significantly to the conservation of farmland quality when utilized by the older generation. At the same time, agricultural socialized services facilitated farmland quality conservation on contracted land more significantly than on transferred land.

Based on the evidence presented, it is essential to recognize that agricultural socialization services not only play an important part in alleviating resource constraints for farmers, but that they also promote the protection of cultivated land quality, thereby improving the quality of cultivated land overall. Due to this, the supply of agricultural socialized services should be optimized, and various types of business entities should be supported to provide multiple types of agricultural socialized services around key weak links for smallholder farmers. Through effective incentives and policy constraints, agricultural socialized service organizations can implement the concept of sustainable development, actively publicize and promote the use of cultivated land conservation techniques, and play a role in service provision as marketing and demonstration. In addition to the optimization of socialized services, farmers themselves should be guided to change their business philosophy and place more emphasis on technology and the promotion of sustainable development. Encouraging farmers to purchase agricultural socialized services to create a virtuous cycle of supply and demand is key. In view of the differences in the impact of agricultural socialized services on farmers with different characteristics, attention should be paid to the different groups of farmers, and those with a higher degree of response should be guided to participate in agricultural socialized services in a more focused way so that agricultural socialized services can become an effective tool as swiftly as possible.

There are some shortcomings in this study that can be addressed in future research. Although the study tried to control for potentially relevant variables, it may still be influenced by unobservable variables such as land quality and climate change. Furthermore, due to data and spatial constraints, this study did not conduct an in-depth analysis of the more impact mechanism of agricultural socialized services on farmland quality conservation by farmers. We intend to address this in future research.

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